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AA 5001 PROGRAMMABLE DISTORTION ANALYZER

REFERENCE GUIDE

AC input and output connections are available on both the front panel and the rear interface. DC signals, corresponding to the displayed reading, are available through the rear interface. At power-up, the instrument performs a self-test and assumes front panel settings. For more detailed information on functions and specifications, see the Operating Instructions in the AA 5001 Instruction manual. Also refer to the warning and caution statements in the Instruction manual.

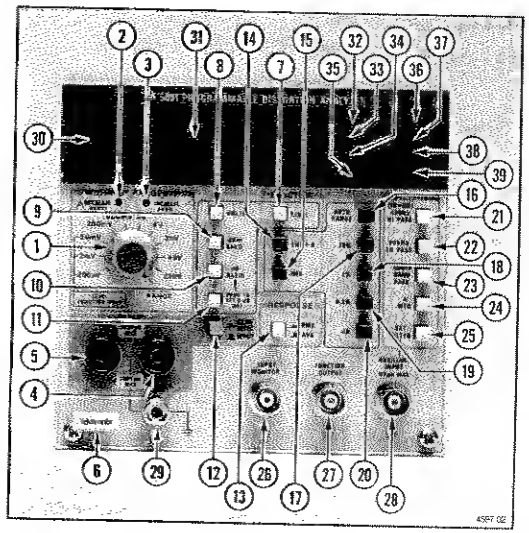

Fig. 1-1. AA 5001 front panel controls.

Description of Controls

(1) INPUT RANGE

Selects input voltage range or AUTORANGE. The three most sensitive ranges operate in the LEVEL FUNCTION only. (The AA 5001 goes to AUTORANGE when in a remote state.)

(6) Release Latch

Pull to remove plug-in from power module.

(7) LEVEL

Button in selects input level measuring function.

(8) VOLTS

Button in selects voltage units for level function.

(9) dBm 600 ohms

Button in selects dBm units for level function. 0dB reference is 0.7746V corresponding to 1 mW into 600 ohms.

(10) dB RATIO

Button in selects dB ratio, with respect to preset level, as units for level function.

(11) PUSH TO SET 0 dB REF

Push button to set display to 0 with input signal applied to INPUT terminals in LEVEL function. dB RATIO and LEVEL pushbuttons must be in for this feature to operate.

(12) REAR INTFC-INPUT

Button in selects rear interface input; button out selects front panel input.

(13) RESPONSE

Button in gives RMS detection (responds to the rms value of the input waveform). Button out gives average detection or quasi-peak detection (option 02 instruments) both are rms calibrated for sinewaves.

(14) THD+N

Button in selects total harmonic distortion function.

(15) IMD

Button in selects intermodulation distortion function.

(16) AUTO RANGE

Button in selects automatic distortion range selection (0.2% to 100% full scale). (The AA 5001 goes to AUTORANGE when in a remote state.)

(17) 20%

Button in selects full scale distortion readout of 20% with 0.01% resolution.

(18) 2%

Button in selects full scale distortion readout of 2% with 0.001% resolution.

(19) 0.2%

Button in selects full scale distortion readout of 0.2% with 0.0001% resolution.

(20) dB

Selects single equivalent 0 dB to −100 dB distortion display range with 0.1 dB resolution.

(21) 400 Hz HI PASS

Button in connects filter before detector circuit in all functions.

(22) 80 kHz LO PASS

Button in connects filter before detector circuit in all functions.

(23) AUDIO BANDPASS

Button in connects filter before detector circuit in all functions.

(24) 'A' WEIGHTING (CCIR WEIGHTING In Option 02 Instruments)

Button in connects filter before detector circuit in all functions.

(25) EXT FILTER

Button in allows connection of external filter between FUNCTION OUTPUT and AUXILIARY INPUT in all functions.

(26) INPUT MONITOR

Provides a buffered sample of the input signal.

(27) FUNCTION OUTPUT

Provides a sample of the selected FUNCTION signal additionally processed by selected filters.

(28) AUXILIARY INPUT

Provides input to the detector circuit when the EXT FILTER button is pressed.

(29) Ground

Provides front panel chassis ground connection.

SECTION 2

PROGRAMMING

Introduction

This section contains information for programming the TEKTRONIX AA 5001 Distortion Analyzer. All instrument functions are programmable via high level commands sent over a general purpose bus (GPIB), as specified in the IEEE Standard 488-1978. The IEEE interface function subsets that apply to the AA 5001 are listed in Table 2-1.

Table 2-1
IEEE 488 INTERFACE FUNCTION SUBSETS

Function	Subset
Source Handshake	SH1
Acceptor Handshake	AH1
Basic Talker	T6
Basic Listener	L4
Service Request	SR1
Remote-Local Function	RL1
Parallel Poll	PP0
Device Clear	DC1
Device Trigger	DT1
Controller Function	C0
Electrical Interface	E2

The AA 5001 responds to query commands when in either the local or remote state. The AA 5001 responds to all other listed commands only when in the remote state.

Figure 2-1 is an abbreviated listing of the AA 5001 commands and their relationship to the front-panel controls, nomenclature, and internal parameters.

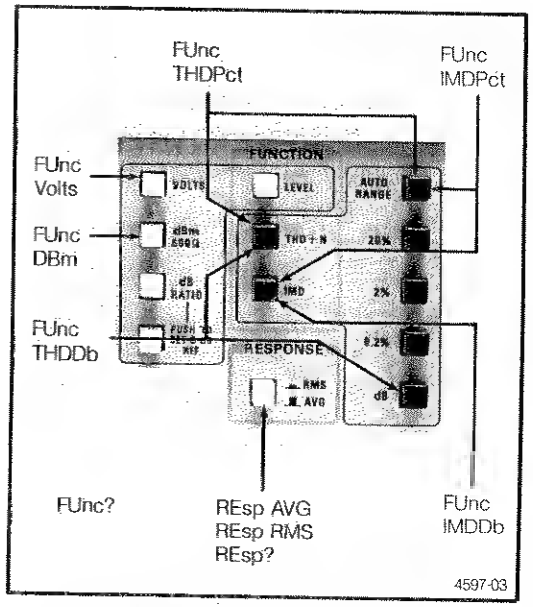

Fig. 2-1a. Instrument commands and relationship to front panel controls.

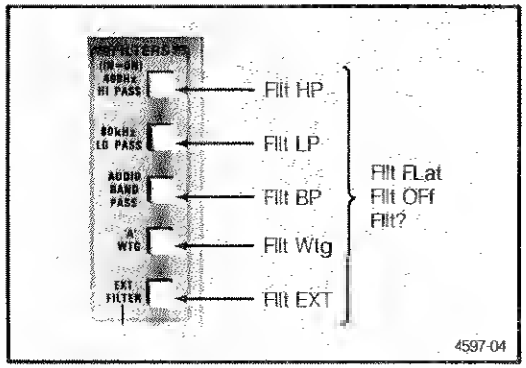

Fig. 2-1b. Instrument commands and relationship to front panel controls.

General

Counts	OPc ON	Points <num>
Counts?	OPc OFF	Points?
	OPc?	
DUs ON	OVer ON	RQs ON
DUs OFF	OVer OFF	RQs OFF
DUs?	OVer?	RQs?
ERRMsg	Help	SENd
ERR?		SET?
EVent?	ID?	
	INit	TEst
FPset		TQI <num>
		TOI?

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Fig. 2-1c. Instrument commands and relationship to front panel controls.

GPIB Address and Terminator Setting

Both the GPIB primary address and message terminator are set from the rear panel. The address may be set to any number from 0 to 31. Address 31 effectively removes the AA 5001 from the bus. Address changes are recognized only at power-up initialization. The message terminator may be set to EOI and LF (ASCII line feed) or EOI ONLY. The AA 5001 is shipped with the address set to decimal 28 and with the message terminator set to EOI ONLY.

Refer to the AA 5001 Instruction manual for additional information.

Command Format

Each command consists of a header, usually followed by an alpha or numeric argument.

Examples:

FUnction Volts
TOlerance 5
SETtings?

All commands except query commands should be sent with a space between header and argument. Additional formatting characters (CR, LF, and SP) may be added between the space and the argument. Query commands must be sent without a space between the header and question mark character.

Argument Format

The AA 5001 accepts the following kinds of numbers for numeric arguments:

- Signed or unsigned integers, including zero. Unsigned integers are interpreted to be positive. Examples: +1, 2, −1, −10.
- Signed or unsigned decimal numbers. Unsigned decimals are interpreted to be positive. Examples: −3.2, +5.0, 1.2.
- Numbers expressed in scientific notation. Examples: +1.0E−2, −1.0E−2, 0.01E+0.

The AA 5001 sends an integer followed by a decimal point (may be in scientific notation) for data and many query responses.

Alpha arguments must be sent as listed in the command list.

Delimiters

The following message delimiters are used to punctuate commands to the AA 5001:

Delimiter	Placement
<space>	After header (except query commands)
<comma>	Between multiple arguments
<semi-colon>	After message unit (command)

Table 2-2
COMMAND LIST

NOTE

Brackets [] indicate the enclosed item is optional, and carets <> indicate a defined element. Capitalized letters are the required characters, the lower case letters may also be used.

Instrument Commands

Counts <num>
Counts?
DUs [ON]
DUs OFf
DUs?
ERRMsg?
ERRor?
EVent?
[FIlters] BPass
[FIlters] EXternal
[FIlters] FLat
[FIlters] HPass
[FIlters] Lpass
FIlters OFf
[FIlters] Wtg
FIlters?
FPset

Table 2-2 (cont)

[FUnction] DBm
[FUnction] IMDDb
[FUnction] IMDPct
[FUnction] THDDb
[FUnction] THDPct
[FUnction] Volts
FUnction?
HElp?
IDentify?
INit
OPc [ON]
OPc OFf
OPc?
OVer [ON]
OVer OFf
OVer?
Points <num>
Points?
[REsponse] AVG (standard instrument only)
[REsponse] AVE (standard instrument only)
[REsponse] RMs
[REsponse] Qpk (Option 2 only)
REsponse?
RQs [ON]
ROs OFf
RQs?
SENd
SETtings?
TEst?
TOlerance <num>
TOlerance?

Table 2-3
AA 5001 COMMANDS AND DESCRIPTIONS
[] = Optional, <> = Defined

Header	Argument	Description
Counts	<num>	Sets the settling algorithm window in units of display counts.
Counts?		Returns the COUNTS setting.
DUs?	[ON] OFf	The DUS command tells the SEND command to delay sending a measurement until settling has occurred. Refer to the description for the SEND command.
DUs?		Returns DUS ON or DUS OFF.
ERRMsg?		Has the same action as the ERROR? query but includes a brief description string in the query response.
ERRor?		Returns an event code and a brief description of the event. If RQS is ON, the code indicates the most recent event.

Table 2-3 (cont)

ERRor?(cont)		The event code is then reset to 0. If ROS is OFF, the code indicates the highest priority event that has occurred.
EVent?		Has the same action as the ERROR? query.
[FIlters]	BPass EXternal FLat HPass Lpass OFf Wtg BPass? FLat?	Each individual command enables the specified filter. FLAT and OFF disable all the filters. NOTE: "A" WEIGHTING is used on the standard instrument only. "CCIR" WEIGHTING is used on Option 2 only. For the setting command, multiple arguments separated by commas are allowed. The arguments are processed from left to right, that is the last argument prevails.

Table 2-3 (cont)

[FILTERS](cont)		The FILTERS heading may be omitted for all arguments except OFF unless multiple arguments are used. If the FILTERS heading is omitted, the arguments ON or OFF may be optionally used. If not used, ON is assumed. BP, LP, and WTG are all mutually exclusive.
Filters?		Returns a list of the filters that are enabled.
FPset		Sets the AA 5001 to the front panel settings even though it is under remote control. This is useful for allowing manually set input level and distortion ranges, as these are otherwise autoranged when in the remote state. Any other setting command made subsequently will defeat FPset.

Table 2-3 (cont)

[FUnction]	DBm IMDDb IMDPct THDDb THDPct Volts	DBM selects level measurement in decibels relative to 0.775 Volts. IMDDB selects intermodulation distortion measurements in decibels. IMDPCT selects intermodulation distortion measurements in percent. THDDB selects total harmonic distortion measurements in decibels. THDPCT selects total harmonic distortion measurements in percent. VOLTS selects level measurement in rms volts. NOTE: DB RATIO is not programmable. References other than 0.775 volts (dBm), if needed, should be calculated by the controller.
FUnction?		Returns the type of measurement selected. The FUnc header is not returned.

Table 2-3 (cont)

HElp?		Returns a list of all valid commands headers.
IDentify?		Returns "ID TEK/AA5001, V81.1,Fx.y;" (standard instruments only) or "ID TEK/AA5001, V81.1,Fx.y, "OPTION 2" only). Fx.y identifies the firmware version number.
INit		Initializes the instrument settings to the following: VOLTS RMS FLAT DUS ON POINTS 3 TOLERANCE 2.0 COUNTS 2.0 OPC OFF OVER OFF RQS ON
OPc	[ON] OFf	Controls the asserting of SRO when a measurement is completed. When OPC is ON and a measurement completes, SRO is asserted until the status is read via a serial poll or until cleared by RQS OFF or a Device Clear.

Table 2-3 (cont)

OPc?		Returns OPC ON or OPC OFF.
OVer	[ON] OFf	Controls the asserting of SRQ for display overange, insufficient level, excessive input level, and unsettled conditions. These conditions are checked only when a measurement is attempted (see SEND command).
OVer?		Returns OVER ON or OVER OFF.
Points	<num>	Sets the number of sample points, 2 through 6, that must be within the settling algorithm's tolerance window for settling to occur.
Points?		Returns the POINTS setting.
[REsponse]	AVErage (std instr only) AVG (std instr only) RMs Qpk (opt 2 only)	Sets the AA 5001 for average (quasi-peak for option 2) or rms response.

Table 2-3 (cont)

REsponse?		Returns the RESPONSE setting.
RQs	[ON] OFF	When RQS is ON, enables service request interrupt. When ROS is OFF, disables service request interrupt. The ERROR? query can be used while RQS is OFF to see if any SRQ type conditions have occurred. SRQ will be asserted for any previously unreported SRQ event when ROS is turned ON after being OFF.
ROs?		Returns ROS ON or RQS OFF.
SENd		Returns a measurement. If the DUS is OFF the most recent display update is returned. Any display reading may be returned only once. If DUS is ON, the measurement must be settled before it is returned. If settling does not occur within

Table 2-3 (cont)

SENd(cont)		six (6) seconds, an average of the last two (2) seconds (6 display updates) is returned and if the OVER is ON, an unsettled SRQ is generated.
SETtings?		Returns a string list of the current settings of the instrument.
TEst?		Causes execution of the ROM test and returns TEST 0 if the test passes, or TEST 394 if the test fails.
TOlerance	<num>	Sets the tolerance window in percent of the reading for the settling algorithm.
TOlerance?		Returns the TOLERANCE setting.

SETTLING ALGORITHM

This Algorithm delays a measurement from being sent until settling has occurred. The Settling Algorithm is enabled by using the DUS ON command. A settled AA 5001 measurement is obtained by using the SEND command to return a measurement with the Settling Algorithm previously enabled .
The AA 5001 is considered settled when a series of measurement points (display updates) are within a specified tolerance of each other. The tolerance window is plus or minus the sum of the values set by the TOLERANCE command (in percent of reading from 0 to 100) and the COUNTS command (in display counts from 0 to 2000). The POINTS command sets the number of measurement points (from 2 to 6) that must be within the tolerance window for settling to occur. In general, specifying as wide of a tolerance window and as few points as the accuracy of the measurement needed allows, will cause the instrument to return a valid measurement with a minimum of delay.

The measurement returned is the most recent measurement point taken at the time settling occurs.

If settling does not occur within approximately six (6) seconds after the SEND command is received, the AA 5001 returns the average of it's last six (6) measurement points (approximately 2 seconds, in duration). Additionally, if the OVER is ON, an unsettled SRO is generated, alerting the controller that averaging has occurred.

Sending Interface Control Messages

Bus communications are performed through use of controller input and output statements. Commands are transmitted in ASCII by TEKTRONIX 4041 and 4050-Series controllers using PRINT statements; INPUT statements are used to return data from the AA 5001. The AA 5001 GPIB address is factory set to decimal address 28; message terminator to EOI ONLY.

```
PRINT @25:"SET?"
INPUT @25:A$
```

Interface control messages are sent to the AA 5001 using WBYTE statements (4050-Series controllers). In the following examples, A and B are the AA 5001 listen and talk addresses. A = AA 5001 primary address + 32; B = address + 64.

Listen (MLA)	WBYTE @ A:
Unlisten (UNL)	WBYTE @ 63:
Talk (MTA)	WBYTE @ B:
Untalk (UNT)	WBYTE @ 95:
Device Clear (DCL)	WBYTE @ 20:
Selected Device Clear (SDC)	WBYTE @ A,4:
Go to Local (GTL)	WBYTE @ A,1:
Remote With Lockout (RWLS)	WBYTE @ A,17:
Local With Lockout (LWLS)	WBYTE @ 17:
Group Execute Trigger (GET)	WBYTE @ A,8:
Serial Poll Enable (SPE)	WBYTE @ 24:
Serial Poll Disable (SPD)	WBYTE @ 25:

Refer to the 4041 and 4050-Series controller manuals for information on using RBYTE statements.

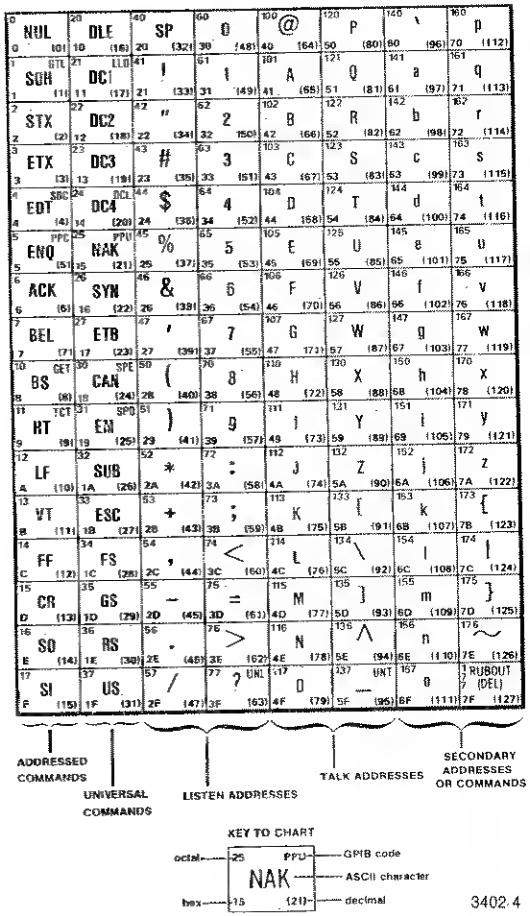

Fig. 2-2. ASCII & IEEE 488 (GPIB) Code Chart.

Power-up Settings

When powered up, the AA 5001 performs a diagnostic self-test. If no internal errors are detected, the instrument enters the Local State (LOCS) and asserts SRO. It assumes the front panel settings and the following:

DUS ON
POINTS 3
TOLERANCE 2.0
COUNTS 2.0
OPC OFF
OVER OFF
ROS ON

If an internal error is found during self test, a front panel error is displayed. See the AA 5001 Instruction manual for front panel error display power-up self tests.

Talker Listener Programs

Refer to the AA 5001 Instruction Manual for additional Talker/Listener program information.

NOTE

The double asterisks shown in the 4052A and 4041 program code lines indicate a line wrap-around and are not part of the program coding.

4052A Controller Program

The following program allows a user to send any AA 5001 commands from the controller to the instrument and return data from the AA 5001 to the controller. The program includes an SRQ handler.

```
540  INIT
550  DIM Aa_response$(300),Aa_command$
**   (100),Addr_list(15)
560  Aa_pri_addr=28
570   !
580  CALL "config",Config_code;Addr_list
590  IF Config_code THEN
600    PRINT "Configuration routine failed due
**     to problem on GPIB."
610    STOP
620  END IF
630   !
640  ON SRQ THEN 790
650   !
660  PRINT "AA 5001 TALKER/LISTENER PROGRAM"
670   !
680  PRINT "Enter command message:  ";
690  INPUT Aa_command$
700  PRINT @Aa_pri_addr :Aa_command$
710  INPUT @Aa_pri_addr :Aa_response$
720  PRINT Aa_response$
730  GO TO 680
740  END
750   !
760   ! Serial poll routine
770  LOCAL Aa_report$
780  DIM Aa_report$(80)
790  POLL Addr_list_index,Spoll_stat;Addr_list
800  IF Addr_list(Adr_list_indx)=Aa_pri_addr
**   THEN
```



```
810    PRINT @Aa_pri_addr:"id?;errmsg?"
820    INPUT @Aa_pri_addr:Aa_report$
830    PRINT "ADDRESS=";Addr_list(Addr_list_
**     indx),"STATUS=";Spoll_stat
840    PRINT Aa_report$
850  END IF
860  RETURN  ! From service request subroutine
```

4041 Controller Program

The following program allows a user to send any AA 5001 command from the controller to the instrument and return data from the AA 5001 to the controller. The program includes an SRQ handler.

```
550    Dim respons$ to 300,command$ to
**     100,aastrem$ to 20
560    Integer aa_pa,spollsta,spolladd,aa_
**     port
570    Aa_pa=28
580    As_port=0
590  !
600    Aastrem$="gpib"&str$(aa_ port)&"(pri=
**     "&str$(aa_ pa)&"):"
610    Open #100:aastrem$
620    Select aastrem$
630    On srq then call pollbus
640    Enable srq
650  !
660 Tlk_lisn:   input prompt "Enter command
**     message: ":command$
670    Input #100 prompt command$:respons$
680    Print respons$ ! AA 5001 returns blank
**     line if not queried in command$
690    Goto tlk_lisn
700    End ! Main
800  Sub pollbus local report$
```

```
810   ! PURPOSE:
820   ! Handles gpib service requests. Polls
**     all primary addresses until
830   ! source of srq is found.  If srq from
**     instrument at AA 5001 primary
840   ! address, routine queries id and error
**     message.
850   !
860   ! LOCAL VARIABLE:
870   ! Report$:  Id and event report from
**     instrument at aa_pa if it has srq.
880   !
890    Dim report$ to 80
900    Poll spollsta,spolladd
910    If spolladd=aa_pa then input #100
**     prompt "id?errmsg?":report$
920    Print report$, "STATUS=";spollsta,
**     "ADDRESS=";spolladd,"PORT=";val
**     (aastrem$)
930    Resume
940    End ! Sub pollbus
```


SECTION 3
ERROR CODES

Status Reporting

Through the Service Request function (defined in the IEEE-488 Standard), the instrument may alert the controller that it requires service. This service request is also a means of indicating that an event (a change in status or an error) has occurred. To service a request, the controller performs a Serial Poll. In response, the instrument returns a Status Byte (STB), which indicates whether it was requesting service or not. The STB can also provide a limited amount of information about the request. The format of the information encoded in the STB is given in Fig. 3-1. Note that, when data bit 8 is set, the STB conveys Device Status information, which is contained in bits 1 through 4.

Because the STB conveys limited information about an event, the events are divided into classes; the Status Byte reports the class. The instrument can provide additional information about many of the events, particularly the errors reported in the Status Byte. After determining that the instrument requested service (by examining the STB), the controller may request the additional information by sending an ERR query (ERR?). In response, the instrument returns a code that defines the event. These codes are described in Table 3-1.

If there is more than one event to be reported, the instrument continues to assert SRQ until it reports all events. (SRQ "stacking" consists of reporting only the latest event of each priority level.) Each event is automatically cleared when it is reported via Serial Poll. The Device Clear (DCL) interface message may be used to clear all events except Power-On.

Commands are provided to control the reporting of some individual events and to disable all service requests. For example, the OPERATION COMPLETE command (OPC) provides individual control over the reporting of a completed measurement. The Request for Service command (RQS) controls whether the instrument reports any events with SRQ.

ROS OFF inhibits all SRO's. When RQS is OFF, the ERR query allows the controller to find out about events without first performing a Serial Poll. With ROS OFF, the controller may send the ERR query at any time and the instrument will return an event waiting to he reported. The controller can clear all events by sending the ERR query until a zero (0) code is returned, or clear all events except Power-Up through the DCL interface message.

With ROS OFF, the controller may perform a Serial Poll, but the Status Byte contains only Device Dependent Status information.

With ROS ON, the STB contains the class of the event; a subsequent error query returns additional information about the previous event reported in the STB.

Error Codes

The error codes for the AA 5001 are classified in two groups: normal condition and abnormal condition codes. When the instrument reports error (event) codes, the power-up condition code is reported first, then abnormal condition codes, and last, normal condition codes. The order in which events in each group are reported depends upon the state of the Service Request (RQS) interrupt. If RQS is on, the first event reported is the most recent event; if ROS is off, the first event is the highest priority event. Table 3-1 lists all AA 5001 event codes, event descriptions, error query responses, serial poll and responses. The list is divided into classes; these classes are defined as follows:

Command Errors—Indicate receipt of a command the instrument cannot understand.

Execution Errors—Indicate the instrument has received a command that it cannot execute.

Internal Errors—Indicate detection of a hardware error.

Execution Warnings—Indicate that the instrument is operating, but the user should be aware of potential problems.

System Events—Indicate an event that is common to instruments in a system; for example, power-up, user request, etc.

Device Dependent Events—Indicate a device dependent event.

Table 3-1
ERROR QUERY AND STATUS INFORMATION

Event	ERROR Query Response
Abnormal Conditions	
Command Errors	
Command header error	101
Header delimiter error	102
Command argument error	103
Argument delimiter error	104
Missing argument	106
Invalid message unit delimiter	107
Execution Errors	
Command not executable in local mode	201
Returned to local, new pending settings lost	202
I/O buffers full, output dumped	203
Argument out of range	205
Group execute trigger ignored	206
Internal Errors	
Interrupt fault	301
System error	302
Math pack error	303

Table 3-1 (cont)

Event	ERROR Query Response
Normal Conditions	
System Events	
Power-up	401
Operation complete	402
Execution Warning	
Display overrange	601
Device Dependent Events	
Insufficient input level	701
Excessive input level	703
Unsettled	704
No Errors or Events	0
With data not ready	128 or 144
With data ready	

NOTE

The 4050-Series controller POLL command returns 0 for serial poll responses above 128; the serial poll responses above 128 can only be obtained by using WBYTE/RBYTE statements.

If 0, STB indicates event class
If 0, STB indicates device class
1 if requesting service
1 indicates an abnormal event
1 if message processor is busy
Define Events

DATA BITS

STATUS BYTE (Example)	8	7	6	5	4	3	2	1	DECIMAL Bit 5 not asserted	DECIMAL Bit 5 asserted
DECIMAL WEIGHT	128	64	32	16	8	4	2	1		
Normal Conditions:										
Power-up	0	1	0	x	0	0	0	1	65	81
Operation complete	0	1	0	x	0	0	1	0	66	82
Display overrange	0	1	0	x	0	1	0	0	68	84
No events	1	0	0	x	0	0	0	0	128	144
Device Dependent Events:										
Insufficient input level	1	1	0	x	0	0	0	1	193	209
Excessive input level	1	1	0	x	0	0	1	1	195	211
Unsettled	1	1	0	x	0	1	0	0	196	212
Abnormal Conditions:										
Command errors	0	1	1	x	0	0	0	1	97	113
Execution errors	0	1	1	x	0	0	1	0	98	114
Internal errors	0	1	1	x	0	0	1	1	99	115

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Fig. 3-1. Definition of STB bits.